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(54) Title of the Invention: ELECTRIC-DISCHARGE SURFACE TREATMENT APPARATUS AND ELECTRIC-DISCHARGE SURFACE TREATMENT METHOD USING THE SAME

(57) Abstract:
[Problem]
An electric-discharge surface treatment apparatus is obtained, by which a surface treatment layer can be formed, on a workpiece, to satisfy a requirements specification.
[Means for Solution]
An electric-discharge surface treatment apparatus includes an electric-discharge treatment means, a requirement-specification storage unit, an electrode-characteristic storage unit, and an electric-discharge-treatment-condition controlling unit. An electric-discharge treatment condition of the electric-discharge treatment means is controlled by the electric-discharge-treatment-condition controlling unit, based on an output result from the electrode-characteristic storage unit and a requirements specification in the requirement-specification storage unit.

CLAIMS

What is claimed is:

1. An electric-discharge surface treatment apparatus comprising:

an electric-discharge treatment means for generating electric discharge, by applying voltage between a green compact electrode made of surface treatment material, or base material of surface treatment material, and a workpiece, so as to form a surface treatment layer on a surface of the workpiece;

a requirement-specification storage unit for storing a requirements specification of the surface treatment layer;

an electrode-characteristic storage unit for storing characteristics related to electric discharge by the green compact electrode; and

an electric-discharge-treatment-condition controlling unit for controlling, based on an output result from the electrode-characteristic storage unit and the requirements specification in the requirement-specification storage unit, an electric-discharge treatment condition of the electric-discharge treatment means.

2. An electric-discharge surface treatment apparatus as recited in claim 1, wherein the electric-discharge treatment condition includes any one of polarity, peak current, open circuit voltage, pulse-on time, pulse-off time, and servo voltage of an electric-discharge pulse.

3. An electric-discharge surface treatment apparatus as recited in claim 1, wherein characteristics of the electrode related to the electric-discharge treatment are material components or particle diameters of electrode, electrode length, electrode area, electrode molding pressure, or gradation characteristics of these.

4. An electric-discharge surface treatment apparatus as recited in claim 3, wherein the gradation characteristics are material components or particle diameters of the electrode.

5. An electric-discharge surface treatment method of forming a surface treatment layer on a surface of a workpiece by electric-discharge treatment by applying voltage between a green compact electrode made of surface treatment material or base material of surface treatment material, and the workpiece,

wherein a condition of the electric-discharge treatment is controlled based on a requirements specification of the surface treatment layer and characteristics related to the electric-discharge treatment by the green compact electrode.

6. An electric-discharge surface treatment method as recited in claim 5, wherein the condition of the electric-discharge treatment is controlled by a state of the

electric-discharge treatment or characteristics of the surface treatment layer.

7. An electric-discharge surface treatment method as recited in claim 5 or claim 6, wherein the condition of the electric-discharge treatment includes any one of polarity, peak current, open circuit voltage, pulse-on time, pulse-off time, and servo voltage of an electric-discharge pulse.

8. An electric-discharge surface treatment method as recited in claim 5 or claim 6, wherein characteristics of the electrode related to the electric-discharge treatment are material components or particle diameters of the electrode, electrode length, electrode area, electrode molding pressure, or gradation characteristics of these.

9. An electric-discharge surface treatment method as recited in claim 8, wherein the gradation characteristics are the material components or the particle diameters of the electrode.

DETAILED DESCRIPTION OF THE INVENTION

[0001]

Technical Field to Which the Invention Pertains

The present invention relates to an electric-discharge surface treatment apparatus for forming, by an electric-discharge surface treatment operation, a surface treatment layer, for example, on a metal or a ceramic surface, and to an electric-discharge surface treatment method using the apparatus,.

[0002]

Prior Art

Fig. 8 is an explanatory view explaining a surface treatment apparatus using an in-liquid electric-discharge method disclosed in, for example, Japanese Patent Application Publication Laid-Open No. H07-70761, by which the surface of a metal workpiece such as aluminum or aluminum alloy is coated using the in-liquid electric-discharge method, and thereby corrosion resistance as well as wear resistance is given. In Fig. 8, numeral 6 denotes a workpiece; numeral 8 denotes machining fluid for which oil such as kerosene is used; numeral 14 denotes a green compact electrode; and numeral 15 denotes a surface treatment layer formed on the workpiece 6. For example, in a case of a Ti group coating film being formed on the surface of the workpiece 6, electric discharge is first generated by the green compact electrode 14, which is made of TiH_2 (titanium hydride) group material, in the machining fluid 8 such as kerosene in which carbon is generated by the electric discharge. Due to this electric discharging, the electrode 14 is consumed, and thereby Ti as its component is released to its interelectrode gap. This Ti reacts with the carbon as a machining-fluid

component generated by thermal decomposition due to the electric discharging, and turns into TiC. As a result, the surface treatment layer 15 is formed on the surface of the workpiece 6.

[0003]

Problems to be Solved by the Invention

However, for example, in a case of the surface treatment being carried out onto the aluminum alloy using the green compact electrode made of TiH_2 (titanium hydride) according to the above described procedure, because hardness difference between the aluminum alloy and the TiC coating film is too large, a problem has occurred that the coating film immediately peels off. Moreover, in a case of material components or particle diameters, electrode lengths, electrode areas of the green compact electrode, or molding pressures when the electrode is produced being different from each other, and in a case of the electrode having inclined characteristics, the electrical conductivity and the thermal conductivity are different depending on portions of the green compact electrode; therefore, in a case of the electric-discharge energy during the surface treatment being constant, because their electrode consumption states are different from each other, a problem has occurred that the facial state deteriorates, and thereby a surface treatment layer is formed in which the adhesiveness as well as the wear resistance is deteriorated. That is, according to the surface treatment method using the conventional electric-discharge treatment apparatus, the surface treatment layer that satisfies the requirements specification has not been able to be formed on the workpiece.

[0004]

An objective of the present invention, which is made to solve the above described problems, is to provide an electric-discharge surface treatment apparatus by which a surface treatment layer that satisfies a requirements specification can be formed on a workpiece and an electric-discharge surface treatment method using the apparatus.

[0005]

Means for Solving the Problem

A first electric-discharge surface treatment apparatus according to the present invention includes an electric-discharge treatment means for generating electric discharge, by applying voltage between a green compact electrode made of surface treatment material, or base material of surface treatment material, and a workpiece, so as to form a surface treatment layer on a surface of the workpiece, a requirement-specification storage unit for storing a requirements specification of the surface treatment layer, an electrode-characteristic storage unit for storing

characteristics related to electric discharge by the green compact electrode, and an electric-discharge-treatment- condition controlling unit for controlling, based on an output result from the electrode-characteristic storage unit and the requirements specification in the requirement-specification storage unit, an electric-discharge treatment condition of the electric-discharge treatment means.

[0006]

In a second electric-discharge surface treatment apparatus according to the present invention, the electric-discharge treatment condition in the first electric-discharge surface treatment apparatus includes any one of polarity, peak current, open circuit voltage, pulse-on time, pulse-off time, and servo voltage of an electric-discharge pulse.

[0007]

In a third electric-discharge surface treatment apparatus according to the present invention, characteristics of the electrode related to the electric-discharge treatment, in the first electric-discharge surface treatment apparatus, are material components or particle diameters of electrode, electrode length, electrode area, electrode molding pressure, or gradation characteristics of these.

[0008]

In a fourth electric-discharge surface treatment apparatus according to the present invention, the gradation characteristics in the third electric-discharge surface treatment apparatus are material components or particle diameters of the electrode.

[0009]

In a first electric-discharge surface treatment method according to the present invention, a surface treatment layer on a surface of a workpiece is formed by electric-discharge treatment by applying voltage between a green compact electrode made of surface treatment material, or base material of surface treatment material, and the workpiece, and a condition of the electric-discharge treatment is controlled based on a requirements specification of the surface treatment layer and characteristics related to the electric-discharge treatment by the green compact electrode.

[0010]

In a second electric-discharge surface treatment method according to the present invention, in the first electric-discharge surface treatment method, the condition of the electric-discharge treatment is controlled by a state of the electric-discharge treatment or characteristics of the surface treatment layer.

[0011]

In a third electric-discharge surface treatment method according to the present invention, in the first or the second electric-discharge surface treatment method, the condition of the electric-discharge treatment includes any one of polarity, peak current, open circuit voltage, pulse-on time, pulse-off time, and servo voltage of an electric-discharge pulse.

[0012]

In a fourth electric-discharge surface treatment method according to the present invention, in the first or the second electric-discharge surface treatment method, characteristics of the electrode related to the electric-discharge treatment are material components or particle diameters of electrode, electrode length, electrode area, electrode molding pressure, or gradation characteristics of these.

[0013]

In a fifth electric-discharge surface treatment method according to the present invention, the gradation characteristics in the fourth electric-discharge surface treatment method are the material components or the particle diameters of the electrode.

[0014]

Best Mode for Carrying Out the Invention

Embodiment 1.

Fig. 1 is an explanatory diagram representing a configuration of an electric-discharge surface treatment apparatus according to a first embodiment of the present invention, and Fig. 2 is a flow chart representing a treatment procedure of an electric-discharge surface treatment operation using the electric-discharge surface treatment apparatus. In these figures, numeral 1 denotes an electric-discharge treatment means for generating electric discharge, by applying voltage between a green compact electrode made of surface treatment material, or base material of surface treatment material, and a workpiece, so as to form a surface treatment layer on a surface of the workpiece; numeral 2 denotes an electrode-characteristic storage unit for storing electrode characteristics related to the electric discharge by the green compact electrode; numeral 3 denotes a requirement-specification storage unit for storing a requirements specification of the surface treatment material formed on the workpiece; and numeral 4 denotes an electric-discharge-treatment-condition controlling unit for controlling, based on an output result from the electrode-characteristic storage unit 2 and the requirements specification in the requirement-specification storage unit, an electric-discharge-treatment condition of

the electric-discharge treatment means 1.

[0015]

First, at Step 1 the requirements specification such as hardness, adhesiveness, film thickness, or facial roughness of a surface treatment layer to be formed on the workpiece is stored in the requirement-specification storage unit 3, and at Step 2 the characteristics, related to the electric discharge by the green compact electrode, such as material components or particle diameters of the electrode, electrode length, electrode area, molding pressure when the electrode is produced, or gradation characteristics of the electrode are stored. Next, at Step 3 the electric-discharge treatment condition including the polarity, peak current, open circuit voltage, pulse-on time, pulse-off time, or servo voltage of an electric-discharge pulse suitable for the electric-discharge treatment is set by the electric-discharge treatment-condition controlling unit 4, at Step 4 the electric-discharge treatment is performed based thereon by the electric-discharge treatment means 1, and then at Step 5 the electric-discharge treatment is finished at a time point when the characteristics of the surface treatment layer reach the requirements-specification level. Here, Step 1 and Step 2 may be switched.

[0016]

Embodiment 2.

A case is explained in which, using the electric-discharge surface treatment apparatus described in Embodiment 1, a surface treatment layer having a smooth hardness variation (a requirements specification of the surface treatment layer) is formed. Fig. 3 is an explanatory view explaining an electric-discharge-treatment operation on the workpiece by the electric-discharge surface treatment apparatus according to Embodiment 1. In the figure, numeral 6 denotes the workpiece, numeral 8 denotes the machining fluid which is oil such as kerosene, numeral 5 denotes a green compact electrode, and numeral 7 denotes a surface treatment layer. As the green compact electrode 5, material having component gradation formed by gradually varying a TiH_2 powder amount and an Ni powder amount (electrode characteristics) was used. That is, the ratio is gradually varied so that, at the side of the workpiece 6, the powder amount of Ni that is relatively soft metal is to be larger than that of TiH_2 including Ti that is relatively hard metal. Next, by setting the electric-discharge treatment condition for forming, using the above described electrode, the surface treatment layer on the workpiece, so as to generate electric discharge with constant electric-discharge energy between the electrode and the workpiece, electric-discharge treatment was performed in the machining fluid 8 such as kerosene, in which carbon is generated by the electric discharge; thus, as represented in the figure, the surface treatment layer 7 having the component gradation could be obtained. That is, the Ni

content is relatively high at the contact portion between the workpiece 6 and the surface treatment layer 7, and as the content decreases toward the upper surface of the surface treatment layer 7, the Ti content obtained in a manner similar to the conventional method increases; therefore, because the hardness variation is more smoothed than in the case of that being formed of only TiC, a hard surface-treatment-layer coating film could be formed, and its peeling could be prevented at the same time.

[0017]

Here, for the green compact electrode 5 used in this embodiment, powders were used, in which the particle diameters are approximately 10 μm, and the content ratio of the Ni powder and the TiH_2 powder is continuously varied from 7:3 to 0:10 (volume percent), so that the powder electrode has the component gradation. For example, the above electrode was produced by a pressure forming method, after powders in which the component mixture ratio is varied were stacked in layers in an electrode mold.

[0018]

As represented in Fig. 4, the workpiece-6 side of the green compact electrode 5 is formed by powders of Ni that is relatively soft metal, while the other side thereof is formed by those of TiH_2 including Ti that is relatively hard metal, and thereby an effect similar to the above can be obtained. Fig. 4 is an explanatory view illustrating a green compact electrode which can be used in Embodiment 2 according to the present invention, in which numeral 9 denotes a green compact electrode, numeral 10 denotes a portion formed of Ni powders, and numeral 11 denotes a portion formed of TiH_2 powders.

[0019]

Although the gradation of the green compact electrode is given by the material content ratio of the electrode, the gradation of the green compact electrode may be given by the particle diameters (for example, 2 - 20 μm) or by both of the electrode material and the particle diameters. Moreover, even if V (vanadium), Nb (niobium), Ta (tantalum), Cr (chrome), Mo (molybdenum), or W (tungsten) other than Ti is used, or a mixture with another metal or ceramic, etc., is used, a similar effect can also be obtained.

[0020]

Embodiment 3.

A case is explained in which a surface treatment layer having excellent facial characteristics (a requirements specification of a surface treatment layer) is formed on

the workpiece using the electric-discharge surface treatment apparatus described in Embodiment 1. Fig. 5 includes explanatory graphs explaining an operation of the electric-discharge-treatment-condition controlling unit of the electric-discharge surface treatment apparatus according to Embodiment 1 of the present invention, in which a characteristic graph (Fig. 5(a)) represents a relationship between electric-discharge treatment energy (electric-discharge treatment conditions) when the green compact electrode including powders whose particle diameters are different (electrode characteristics) and facial states, and a characteristic graph (Fig. 5(b)) represents a relationship between the electric-discharge energy and the thickness of the surface treatment layer. In the figure, the electric-discharge treatment energy is the multiplication of the peak current and the pulse-on time. In a case of the particle diameter of 5 μm (white circles in the figure), the value of the electric-discharge treatment energy is selected from a range of E1 - E2 from a view point of the facial characteristics as represented in Fig. 5(a), and thus, the most suitable value of the electric-discharge treatment energy may be determined from a view point of the film thickness as represented in Fig. 5(b). On the other hand, in a case of the particle diameter of 1 μm (white up-pointing triangles in the figure), if the electric-discharge treatment energy used in the case of the particle diameter of 5 μm is applied, thick film thickness can be obtained, but the facial characteristics deteriorates; therefore, the electric-discharge treatment energy is selected from a range of E0 –E1, so that an excellent coating film can be formed.

[0021]

Embodiment 4.

Fig. 6 is an explanatory diagram representing a configuration of an electric-discharge surface treatment apparatus according to a fourth embodiment of the present invention, and Fig. 7 is a flow chart representing a treatment procedure of an electric-discharge surface treatment operation using this electric-discharge surface treatment apparatus. In these figures, numerals 1 – 4 are the same as those in Fig. 1, numeral 12 denotes an electric-discharge-treatment-state detecting unit for detecting whether or not electric discharge by the electric-discharge treatment means 1 is normal (for example, whether a short circuit occurs), and numeral 13 denotes a characteristic detecting unit of the surface treatment layer for detecting whether characteristics of the surface treatment layer are normal. That is, the electric-discharge condition initially set is assumed not to be affected by disturbance; however, a state actually arises that cannot be handled with the above condition due to a state of treatment debris being eliminated, etc. It is detected, for example, whether it is a short circuited state and electric discharging is continuously generated. Moreover, for example, if the electric-discharge treatment condition initially set is inappropriate, or the electric-discharge treatment condition becomes inappropriate

with proceeding of electric discharging, the characteristics of the surface treatment layer deteriorates due to deterioration of the facial roughness and non-uniformity of the film thickness. Therefore, the electric-discharge treatment state can be detected from the characteristics of the surface layer.

[0022]

First, in Fig. 7, the electric-discharge treatment operation is performed up to Step 4 by the electric-discharge treatment means 1 in a manner similar to that in Fig. 2. When the treatment time increases, the characteristics of the green compact electrode vary during the electric-discharge treatment; however, by dealing with the variation, a surface treatment layer more matched to the requirements specification can be obtained. That is, at Steps 6 and 7 in Fig. 7, the electric-discharge treatment state is determined to be normal or not during the electric-discharge treatment operation. If the state is determined to be abnormal, the electric-discharge treatment condition is corrected by the electric-discharge-treatment-condition controlling unit 4 If the state is normal, the characteristics of the surface treatment layer formed on the workpiece are determined to be normal or not at Steps 8 and 9. If the characteristics are determined to be abnormal, the electric-discharge treatment condition is corrected by the electric-discharge-treatment-condition controlling unit 4. If the characteristics are normal, at Step 5, at a point when the surface treatment layer reaches the requirements specification, the electric-discharge treatment operation is finished. Here, Step 1 and Step 2, and Steps 6, 7 and Steps 8, 9 may be reversed, respectively; moreover, regarding Steps 6 and 7, and Steps 8 and 9, the number of execution times may be previously determined.

[0023]

As the electric-discharge surface treatment method using the electric-discharge surface treatment apparatus described in Embodiment 1, determination of the electric-discharge treatment condition by the electric-discharge-treatment-condition controlling unit may be executed only once before the surface treatment operation. However, in a case of the characteristics of the green compact electrode, etc. varying during the treatment, or in a case of the surface treatment layer to be formed being a thick film (approximately 20 μm), in order to obtain a high-quality surface treatment layer, as the electric-discharge surface treatment method using the electric-discharge surface treatment apparatus described in Embodiment 4, the electric-discharge condition is desirable to be determined and corrected by the electric-discharge-treatment-condition controlling unit for a plurality of times.

[0024]

Advantageous Effect of the Invention

According to the first electric-discharge surface treatment apparatus, the apparatus includes the electric-discharge treatment means for generating electric discharge, by applying voltage between the green compact electrode made of surface treatment material, or base material of surface treatment material, and the workpiece, so as to form the surface treatment layer on the surface of the workpiece, the requirement-specification storage unit for storing the requirements specification of the surface treatment layer, the electrode-characteristic storage unit for storing characteristics related to electric discharge by the green compact electrode, and the electric-discharge-treatment-condition controlling unit for controlling, based on the output result from the electrode-characteristic storage unit and the requirements specification in the requirement-specification storage unit, the electric-discharge treatment condition of the electric-discharge treatment means; thereby, an effect is obtained that the surface treatment layer which satisfies the requirements specification can be formed on the workpiece.

[0025]

According to the second electric-discharge surface treatment apparatus, the electric-discharge treatment condition in the first electric-discharge surface treatment apparatus includes any one of the polarity, the peak current, the open circuit voltage, the pulse-on time, the pulse-off time, and the servo voltage of the electric-discharge pulse; thereby, an effect is obtained that the surface treatment layer which satisfies the requirements specification can be formed on the workpiece.

[0026]

According to the third electric-discharge surface treatment apparatus, the characteristics of the electrode related to the electric-discharge treatment, in the first electric-discharge surface treatment apparatus, are the material components or the particle diameters of the electrode, the electrode length, the electrode area, the electrode molding pressure, or gradation characteristics of these; thereby, an effect is obtained that the surface treatment layer which satisfies the requirements specification can be formed on the workpiece.

[0027]

According to the fourth electric-discharge surface treatment apparatus, the gradation characteristics in the third electric-discharge surface treatment apparatus are the material components or the particle diameters of the electrode; thereby, an effect is obtained that the surface treatment layer which satisfies the requirements specification can be formed on the workpiece.

[0028]

The first electric-discharge surface treatment method is a method of forming the surface treatment layer on the surface of the workpiece by the electric-discharge treatment by applying voltage between the green compact electrode made of the surface treatment material, or the base material thereof, and the workpiece, , in which the condition of the electric-discharge treatment is controlled based on the requirements specification of the surface treatment layer and the characteristics related to the electric-discharge treatment by the green compact electrode; thereby, an effect is obtained that the surface treatment layer which satisfies the requirements specification can be formed on the workpiece.

[0029]

According to the second electric-discharge surface treatment method, in the first electric-discharge surface treatment method, the condition of the electric-discharge treatment is controlled by the state of the electric-discharge treatment or the characteristics of the surface treatment layer; thereby, an effect is obtained that the surface treatment layer which further satisfies the requirements specification can be formed on the workpiece.

[0030]

According to the third electric-discharge surface treatment method, in the first or the second electric-discharge surface treatment method, the condition of the electric-discharge treatment includes any one of the polarity, the peak current, the open circuit voltage, the pulse-on time, the pulse-off time, and the servo voltage of the electric-discharge pulse; thereby, an effect is obtained that the surface treatment layer which satisfies the requirements specification can be formed on the workpiece.

[0031]

According to the fourth electric-discharge surface treatment method, in the first or the second electric-discharge surface treatment method, the characteristics of the electrode related to the electric-discharge treatment are the material components or the particle diameters of the electrode, the electrode length, the electrode area, the electrode molding pressure, or gradation characteristics of these; thereby, an effect is obtained that the surface treatment layer which satisfies the requirements specification can be formed on the workpiece.

[0032]

According to the fifth electric-discharge surface treatment method, the gradation characteristics in the fourth electric-discharge surface treatment method are the material components or the particle diameters of the electrode; thereby, an effect is

obtained that the surface treatment layer which satisfies the requirements specification can be formed on the workpiece.

Brief Description of the Drawings

Fig. 1 is an explanatory view representing a configuration of an electric-discharge surface treatment apparatus related to the present invention;

Fig. 2 is a flow chart representing a treatment procedure of an electric-discharge surface treatment operation using the electric-discharge surface treatment apparatus related to the present invention;

Fig. 3 is an explanatory view explaining an electric-discharge treatment operation on a workpiece using the electric-discharge surface treatment apparatus related to the present invention;

Fig.4 is an explanatory view of a green compact electrode related to the present invention;

Fig. 5 is explanatory graphs explaining an operation of an electric-discharge-treatment-condition controlling unit in the electric-discharge surface treatment apparatus related to the present invention;

Fig. 6 is an explanatory view representing a configuration of an electric-discharge surface treatment apparatus related to the present invention;

Fig. 7 is a flow chart representing a treatment procedure of an electric-discharge surface treatment operation using the electric-discharge surface treatment apparatus related to the present invention; and

Fig. 8 is an explanatory view explaining an electric-discharge treatment operation of a workpiece using a conventional electric-discharge surface treatment apparatus.

Explanation of Symbols

5 Green compact electrode

7 Surface treatment layer

が電極材料成分または粒径のものであり、被処理材に要求仕様を満たす表面処理層を形成することができるという効果がある。

【００２８】本発明の第１の放電表面処理方法は、表面処理材料または表面処理材料の元となる材料からなる圧粉体電極と被処理材との間に電圧を印加して放電処理することにより上記被処理材の表面に表面処理層を形成する放電表面処理方法において、上記表面処理層の要求仕様と、上記圧粉体電極の放電処理に関連する特性とにより上記放電処理の放電処理条件を制御する方法であり、被処理材に要求仕様を満たす表面処理層を形成することができるという効果がある。

【００２９】本発明の第２の放電表面処理方法は、上記第１の放電表面処理装置において、放電処理条件の制御を放電処理状態または表面処理層の性状によりおこなう方法であり、被処理材に要求仕様をさらに満たす表面処理層を形成することができるという効果がある。

【００３０】本発明の第３の放電表面処理方法は、上記第１または第２の放電表面処理方法において、放電処理条件が放電パルスの極性、ピーク電流、オープン電圧、パルスオン時間、パルスオフ時間またはサーボ電圧であり、被処理材により十分に要求仕様を満たす表面処理層を形成することができるという効果がある。

【００３１】本発明の第４の放電表面処理方法は、上記第１または第２の放電表面処理方法において、放電処理に関連する電極の特性が、電極材料成分もしくは粒径、＊

＊電極長さ、電極面積、電極成型圧または傾斜的上記特性であり、被処理材に要求仕様を満たす表面処理層を形成することができるという効果がある。

【００３２】本発明の第５の放電表面処理方法は、上記第４の放電表面処理方法において、傾斜的特性が電極材料成分または粒径であり、被処理材に要求仕様を満たす表面処理層を形成することができるという効果がある。

【図面の簡単な説明】

【図１】　本発明に係わる放電表面処理装置の構成を示す説明図である。

【図２】　本発明に係わる放電表面処理装置を用いた放電表面処理の処理過程を示すフローチャートである。

【図３】　本発明に係わる放電表面処理装置による被処理材の放電処理を説明する説明図である。

【図４】　本発明に係わる圧粉体電極の説明図である。

【図５】　本発明に係わる放電表面処理装置における放電処理条件制御部の動作を説明するための説明図である。

【図６】　本発明に係わる放電表面処理装置の構成を示す説明図である。

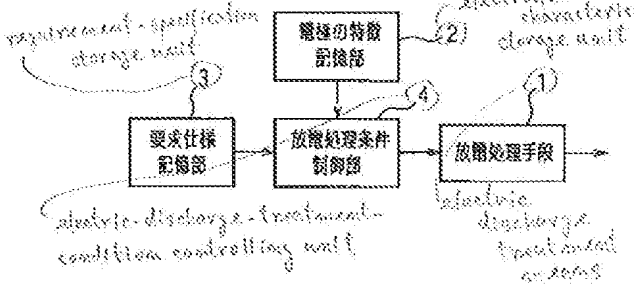
【図７】　本発明に係わる放電表面処理装置を用いた放電表面処理の処理過程を示すフローチャートである。

【図８】　従来の放電表面処理装置による被処理材の放電処理を説明する説明図である。

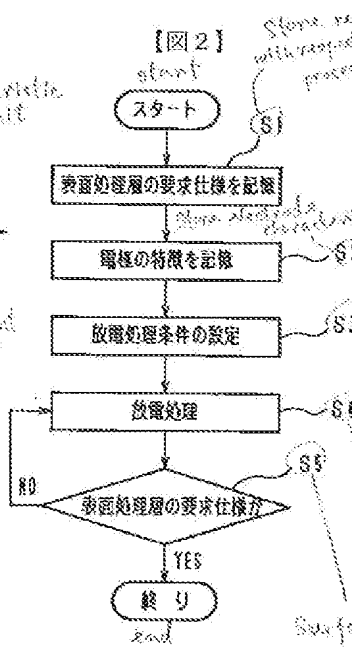
【符号の説明】

５　圧粉体電極、７　表面処理層。

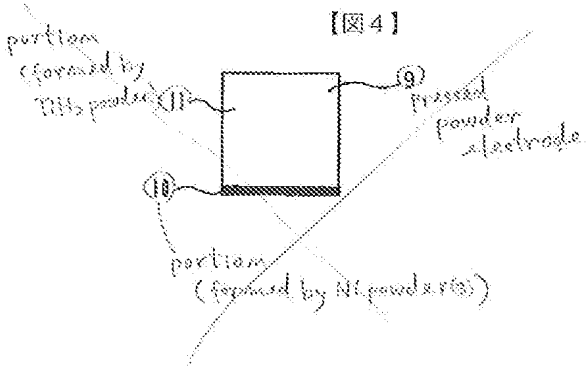
【図１】



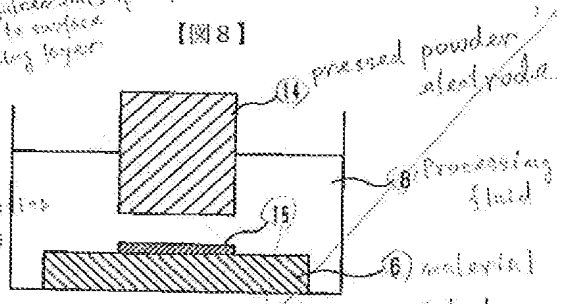
【図２】



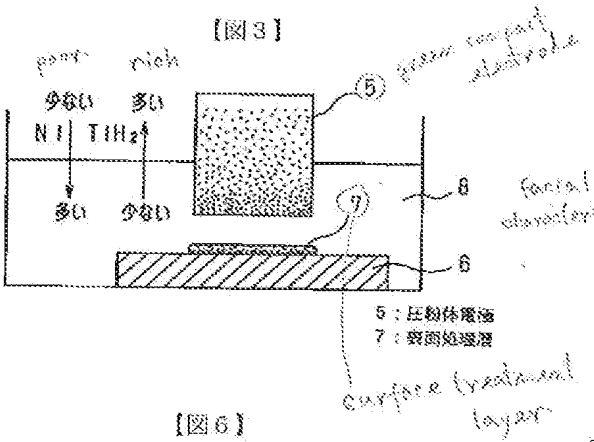
【図４】



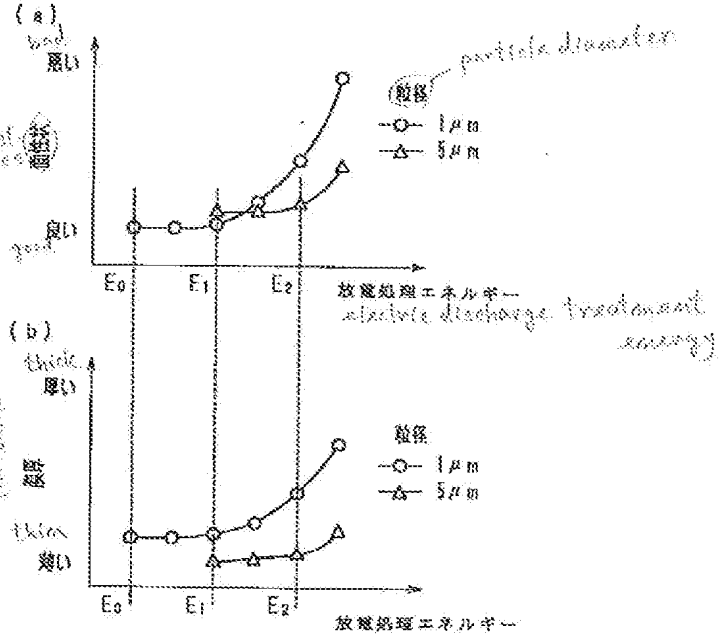
【図８】



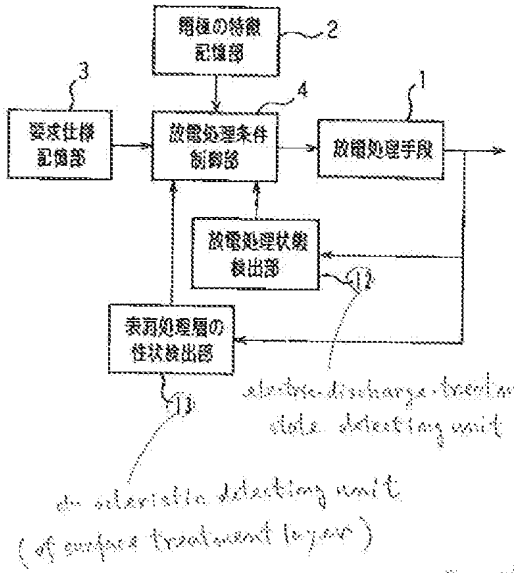
【図３】


poor
rich
少ない
多い
Ni
TiH₂
多い
少ない
⑤
6
7
5：圧粉体電極
7：表面処理層
press-compact electrode
surface treatment layer

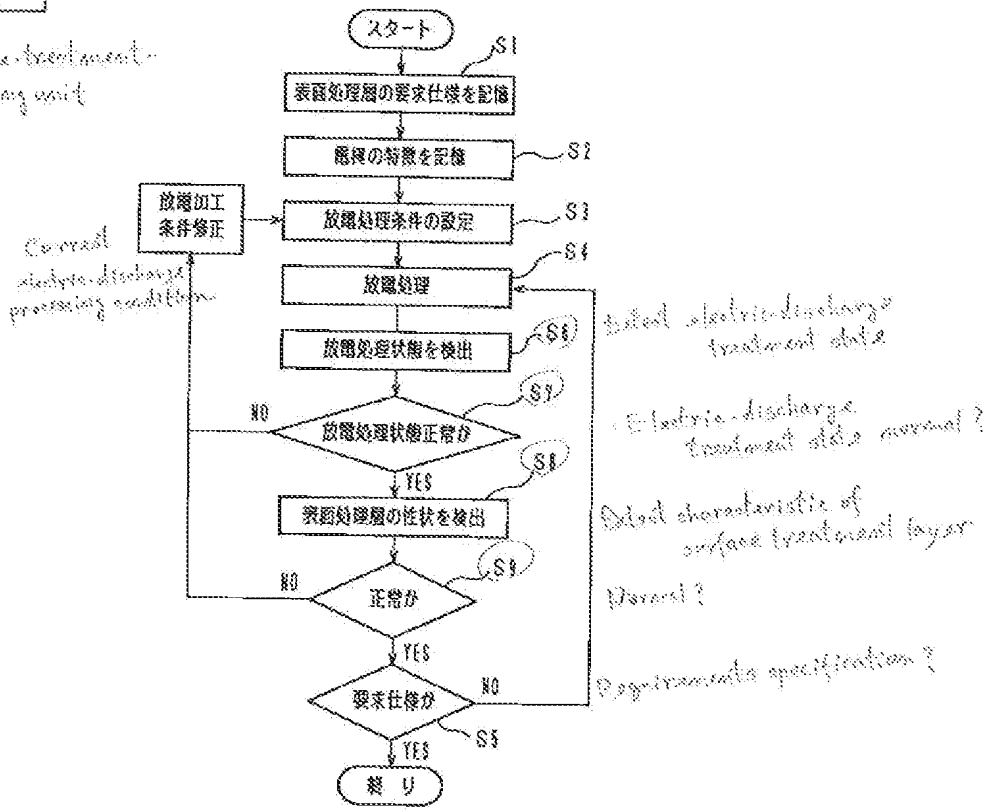
【図５】


(a)
bad
悪い
良い
good
粒径
1μm
5μm
particle diameter
E₀
E₁
E₂
放電処理エネルギー
electric discharge treatment energy
(b)
thick
厚い
薄い
thin
粒径
1μm
5μm
E₀
E₁
E₂
放電処理エネルギー

【図６】


電極の特徴記憶部
2
3
要求仕様記憶部
4
放電処理条件制御部
1
放電処理手段
放電処理状態検出部
12
表面処理層の性状検出器
13
electric-discharge-treatment-state detecting unit
characteristic detecting unit (of surface treatment layer)

【図７】


スタート
S1
表面処理層の要求仕様を記憶
電極の特徴を記憶
S2
放電加工条件修正
S3
放電処理条件の設定
S4
放電処理
S6
放電処理状態を検出
S7
NO
放電処理状態正常か
YES
S8
表面処理層の性状を検出
S9
NO
正常か
YES
要求仕様か
NO
YES
S5
終 り
Correct electric-discharge processing condition
Detect electric-discharge treatment state
Electric-discharge treatment state normal?
Detect characteristic of surface treatment layer
Normal?
Prog-ramm-ata specification?